

CAPBLAT: An Innovative Computer-Assisted Assessment Tool for Problem Based Learning

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Abstract

This paper presents the development and implementation of Computer-Assisted Assessments (CAA) for helping lecturer in assessing students' achievements on the Problem-Based Learning (PBL) Approach. PBL Assessment is typically formative; it includes delivery achievement feedback for the student, with the aim of improving their skills. The use of CAA in PBL gives advantages for both of lecturer and students by providing them with detailed formative feedback on their learning achievements compare to conventional assessment. It also reduces lecturer's tedious load by automating parts of the task of marking students' work. The methodology applied to this research was literature review and investigation of practitioners' perception about assessment in PBL. The literatures showed that there are methods of assessments that have been used successfully in PBL, but the research selected seven methods as a PBL assessment framework; there are "Peer-assessment, Self-assessment, Group-presentation, Individual-activities, Group-report assessment, pre-test and post-test assessment." The framework applied to the tool that encompasses the use of computer (called with CAPBLAT) for helping lecturer in assessing students' achievements. In addition, the CAPBLAT helps to store assessment material, deliver assessment, and does an auto-rating of the assessment result.

Keywords: Computer-Assisted Assessment, Problem-Based Learning, peer-assessment, self-assessment.

1. Introduction

Problem-Based Learning (PBL) is one of the learning methods that is based on student-centered learning[1]. PBL emphasizes the lecturer in facilitating collaborative learning. They conventionally play a little role in the formal assessment process. With the recent focus on assessment, lecturers have become more attuned on how to assess students in PBL. Assessment should be designed for the purposes of improving students' and leading to further student improvement.

In PBL method, the students are actively engaged in learning in the classroom and demonstrate their progress as they master the content, or problem-solving skills, this method provides numerous opportunities for using some method of assessment[2]. Furthermore, PBL is processes leading to a variety of outcomes and that the challenge is to use assessment to contribute to more effective learning, not merely to lead to marks or grades[2]. Because of these reasons, when conducting PBL approach, the lecturer workloads' increase, and conventional methods of assessment make it progressively more difficult to conduct effective assessment and provide the students with detailed and specific feedback. Hence, it is a thought of this research to design an assessment tool that can be used to decrease the lecturer workload. The purposes of this paper are to identify some specific assessment tools that can be used in PBL, and to describe ways to develop a computer-based tool for PBL assessment.

The reason why we propose using computer-based in PBL assessment is because of the use of computer in assessment has many advantages over conventional assessment. The advantages include: quick feedback to students, saving of time in marking, consistently in marking and improve monitoring in students[3]. With these advantages, it hopes will overcome the shortcoming in PBL assessment i.e. computer can assist lecturers and lessen their burden when conducting the assessment process.

The following two research questions will be used as guidance to lead in conducting the research: - What the methods of assessment those are appropriate for PBL? - How can computer-based assist to overcome the complexity and tediousness of the PBL assessment?

The research proposes a conceptual framework for PBL assessment, which provides the holistic approach for assessing students' process skills and to assist lecturers in assessing their students. The research also proposes an assessment tool to guide lecturers in PBL approach especially assist them in assessment. The outcome of the research is CAPBLAT, which is a Computer-assisted PBL assessment tool that has been developed based on the framework.

1.1. Problem-Based Learning Assessment

The goal of PBL is to enhance students' ability to utilize different process skills such as the development of critical thinking or reasoning, high professional competency, problem-solving abilities, knowledge acquisition, the ability to work productively as a team member and take decisions in unfamiliar situations. In addition, this PBL also gives the acquisition of skills that support self-directed learning, self-evaluation, and adaptation to change[4-8].

In PBL, it is important to ensure that students are assessed effectively to achieve the PBL goals. This situation means that PBL assessment should be consistent with the goal of PBL, or the goals of PBL must be included in the learning outcomes of assessment[7].

One of the principles in PBL assessment is to match the assessment method to the learning outcomes, i.e. PBL goals and course objective[9]. PBL assessment should not only focus on the process skills; however, it also must consider student achievement of the course objectives promoted by PBL.

Consequently, when practicing PBL, a lecturer must prepare an appropriate method on how to assess students accurately in obtaining the learning outcomes. Hence, determining a method of assessment in PBL method plays a vital part during the learning process. This is because each PBL practitioner considers using different types of assessment methods for the purposes of improving their students' performance. This can be seen from the literatures studied during the research where many literatures discussed about approaches to PBL, such as curriculum design, the role of the instructor and the role of learner, and various other aspects but much less attention has been given to assessment in PBL. If there is literature discussed about PBL assessment, surely the author was using a different type of assessment method from other authors.

With regard to the many different assessment methods that can be used in PBL, Macdonald and Savin-Baden[10] list some of the forms of assessment that have been used successfully with PBL, as be listed in table 1. It constitutes anomalous, if during PBL session a lecturer obtrudes using all of these assessment methods. Thus, in this research we identify what methods are suitable and common uses for PBL assessment. To answer this question, it will be discussed in session 2.

1.2. Computer-Assisted Assessment

Computer-Assisted Assessment (CAA) generally defined as the use of computers in assessment to assess students' progress. CAA can also be defined as an approach to assess students learning, and it is in general directly made via a computer whereas CAA is used to manage or support the assessment process[3, 11, 12].

As asserted by Bull and Danson[3], other terms used in the literature and practice to describe types of CAA include: web-based assessment, computer-based assessment, online assessment, and computer-aided assessment. While the term that is used in this paper can be CAA and/or computer-based thus serve alternately.

Depending on circumstances, the use of CAA may stand alone and specific to certain machines within a computer lab, based on a local network (intranet) or as is increasingly common, web based. Likewise, with the nature of the assessments may also differ. It may be formative or summative[13]. For the formative, it allows to contribute on-going feedback of student's progress either during the assessment or after. Otherwise, it may be summative, contributing to a student's full mark.

There are key advantages of CAA, such as quick feedback to students, saving of time in marking, consistently in marking and improve monitoring in students[3]. This mean that using of CAA in PBL can give advantages for both of lecturer and students to provide them with the detailed formative feedback for their learning achievements compared to conventional assessment.

Table 1. Methods of Assessment in PBL Practices

Method	Description	Note
Group presentation	Asking the students to submit their work orally or in a written form as a collaborative piece model the process of PBL	Difficult to mark (content, process, presentation or a combination of these being marked?)
Individual presentation	Students are asked to submit the component of work that they have researched for their contribution to the overall solution or management of the problem scenario.	Apart from having some problem with the above method, this is also time-consuming with large cohorts.
Tripartite assessment (Savin-Baden 2003)	a. The group submits a report for which they receive a mark. b. The individual submits the piece of work they researched. c. The individual writes an account of the group process that is linked to the theory of group work.	These three components are added together to form the overall individual mark. The advantage of this is that it does not privilege some students who do less work, and an individual student will be responsible for gaining two-thirds of the marks.
Case-based individual essay	Student is presented with a case scenario which they respond to in the form of an essay. Students may be given a choice of scenarios from which to choose.	This links well with PBL but still tends to focus largely on cognitive abilities (unless students are allowed to use narrative style essays).
Portfolio	A purposeful collection of student work showing efforts, progress and achievements over time.	These can be unwieldy if not managed well and are difficult to mark. Maybe time-consuming to develop and assess Can be difficult to determine assessment criteria.
Triple jump (Painvin et al, 1979; Powles et al, 1981)	Has three phases: hop, step and jump. In the hop phase the tutor questions the student, thus they are caught on the hop. The step phase allows the student time to research the findings and hypotheses that have emerged from the hop phase. In the jump phase they are expected to provide the tutor with a written report of their findings.	it is time-consuming and costly and tends only to be used in well-funded programmes with small student numbers.
Self-assessment	Involves students judging their own work. It may include essays, presentations, reports, and reflective diaries.	This works well with PBL. One of the difficulties with this assessment is the tendency to make judgments about what the students meant rather than what they actually achieved.
Peer assessment	Involves students making judgments about other students' work. This is generally used for presentations and practical but it can also be used for essays and exam scripts.	A good fit with PBL. Providing students with an assessment rubric often helps guide the peer evaluation process even better.
Viva voce examinations	Oral examinations after completing the problem. Oral examinations tend to test at a low taxonomic level, factual knowledge rather than problem solving.	It's best done in practice situations and, although they are very effective, they can be costly, time consuming and extremely stressful for the student.
Reflective (online) journals	Students hand them in each week and receive a mark at the end of each term/semester.	These have worked well in engineering and health. Students tend to be more open and honest about their learning than one would expect and these can be criterion referenced.
Facilitator/tutor assessment	Tutor assesses his/her students' performances and the products of the group work.	It is usually better for assessment in PBL to be done anonymously, as in most other assessment. If assessment of group process is to be undertaken then this is best done by someone other than the group facilitator.
Reports	Requiring written reports allows students to practice this form of communication, particularly if the word allowance is short and it is used in the final year, as it can promote succinct, critical pieces of work.	Written communication is an important skill for students to acquire.
Patchwork text (Winter, R. et al, 1999)	This is a way of getting students to present their work in written form. Students build up text in course work over a number of weeks. Each component of work is shared with other students and they are expected to use different styles, such as a commentary on a lecture, a personal account, and a book review.	This kind of assessment fits well with PBL because of its emphasis on critique and self-questioning.

Source: Macdonald and Savin-Baden (2004)[10]

It also can reduce lectures tedious load by automating parts of the task of marking students' work and the student gets an instant and objective score with specific and timely feedback. This because of the detailed scoring data is already digitized and the possibility of automated score uploads to central repositories such as a student records system offers administrative benefits [3].

2. Problem-Based Learning Assessment Framework (PBLAsF)

In order to answer the research question "What the methods of assessment those are appropriate for PBL?" the research performed study literatures about assessment in PBL. The literatures listed some of the assessments' methods that have been used successfully with PBL[10], has been discussed in the previous session. The literatures supported by initial survey, a questionnaire was distributed to five lecturers as respondents to the survey whom are experts in practicing PBL method from a different range of subjects' areas or backgrounds of studies. The questionnaires were about PBL experiences and what commonly PBL Assessment used among the lecturers (for more detail, please see in session 5.1.).

The literatures and initial survey give reference to the research in selecting appropriate PBL assessment from the listed types of assessment methods, which has been detailed in table1. The following table 2 is the selected appropriated assessment methods in the research, which called with Problem-Based Learning Assessment Framework (PBLAsF).

Table 2. PBLAsF (Problem-Based Learning Assessment Framework).

Methods	Description	Skills to be assessed	Instruments
Self-Assessment	Self-assessment involves students making judgments about their own work. (Assess their own performanc	Skills (rubric) for team work skills: - Self-contribution - Cooperation within team member - Responsibility to team members	Self-Assessment
Peer Assessment	Students are making assessment decisions on other students' work. (Assess performance their peer)	Skills for team work skills: - Team member contribution - Cooperation within team member - Responsibility to team members	Peer-Assessment
Tutor Assessment	Tutor assesses his/her students' performances and the products of the group work (report & presentation)	- Critical analysis skills - Communication skills - Critical skills - Problem solving skills - Self-directed learning - Communication skills - Collaborative work	Group report Assessment Individual in group activities Group Presentation:
Content Knowledge Assessment	To assess student knowledge of subject. Pre-Test; to measure students understanding on subject. Post-Test; to know student attainment in subject knowledge. (The question about subject the student comprehension)	- Subject knowledge Comprehension Skills - Subject knowledge Comprehension Skills (Knowledge building skills)	Pre-Test Pos-Test/ Final-Test

3. CAPBLAT (Computer-Assisted Problem-Based Learning Assessment Tool)

CAPBLAT abbreviation for Computer-Assisted Problem-Based Learning Assessment Tool is a computer-based assessment tool for assessing students' progress in PBL approach.

The purpose of CAPBLAT development is to provide a computer-based tool for PBL assessment to assist lecturer conduct PBL teaching method and effective assess students learning progress and provide the students with detailed and specific feedback. In order to achieved technology acceptance, the CAPBLAT was developed based on the PBLAsF, which consist of seven assessment methods, namely 1) Peer-Assessment, 2) Sel-Assessment 3) Individual-Activity Assessment, 4) Group-Report Assessment, 5) Group-Presentation Assessment 6) Pre-test 7) Post-test/Final-test, as described in table 1.

CAPBLAT has several features, especially when utilized for PBL assessment. CAPBLAT can also be used in others teaching and learning approach, namely active learning and conventional learning approach. Some typical features of CAPBLAT are:

- Tutor assessment (Individual-activity assessment, Group-report assessment, Group-presentation assessment)
- Student's assessment (Peer-assessment, Self-assessment)
- Subject content assessment (pre-test, post-test, final test)
- Create a PBL session
- Auto generated and manually generated group members.
- Create and publish criteria of assessment
- Send a notification to students
- Auto marking
- Monitor students' progress
- Display results to students and lecturers.
- Send a quick Feedback to students.
- Upload teaching material (word, pdf, ppt, video)
- Upload/download course outline (L1)

In order to make the CAPBLAT to be user friendly, the CAPBLAT is provided with well-designed menus and navigations throughout the user interfaces. This will alleviate the tediousness during user interaction. This will be discussed in previous session. The following figure is an example of the home page of CAPBLAT user interface design.



Figure 1. CAPBLAT Login Screenshots

4. Research Method

The research concerns on the development of computer-based tool assessment based on a certain framework of PBL assessment. According to figure 2, the research focuses on the necessary review of literatures, which discussed about PBL assessment of students' performances, especially based on critical reviews of existing PBL assessment that has been used by PBL practitioners. In addition, the research conducted an initial survey by involved PBL practitioners to identify assessment methods that have been used in their PBL approach, and to verify the selected method (PBLAsF).

The tool development consists of three steps. During this phase, designing a Business Process Diagram (BPD) to define a "to-be" business process was modeled using a tool called Business Process Modeling Notation (BPMN). The BPD design helps to construct a use case diagram in order to capture user requirement utilizing the UML use case diagrams. Use case diagram was designed to develop a tool (software) for PBL assessment. The main deliverable of this phase is Computer-Assisted PBL Tools (CAPBLAT). More detail explanations about the research method is as Figure 2.

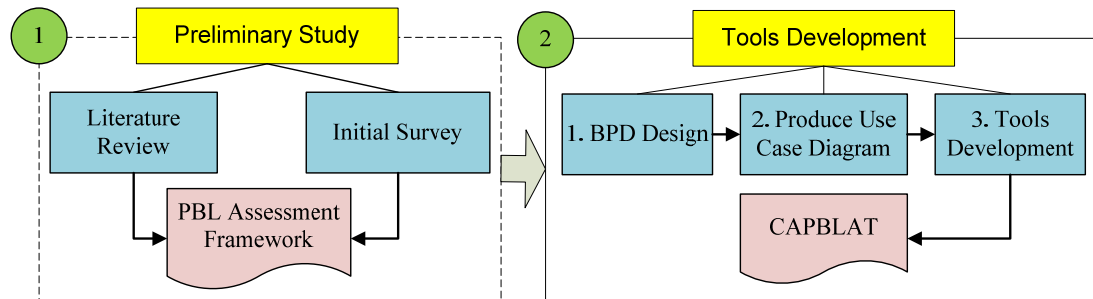


Figure 2. Research Design

Research Participants

The research selected five lecturers as participants (purposive sampling) who are expert or at least practiced PBL approach to their teaching and learning. The participants were from the various backgrounds of studies and different faculties. The research conducting an initial survey by involved them to identify assessment methods, which have been common used in their PBL approach. The details procedure and result of the initial survey will be described in the next session.

5. Results and Discussion

5.1. Preliminary Study

This session discusses about the initial survey which has been conducted during the research to support the literature review in order to answer the research question "What the methods of assessment those are appropriate for PBL?" A questionnaire was developed and then piloted with five lecturers who teaching using PBL approach. The initial survey aims to identify assessment methods that have been used commonly in the PBL approach. The first section of the questionnaire focused on lecturers' background of study. Table 3 details the participants. Pseudonyms are used to protect identities.

Table 3: Details of Initial Survey Participants

Participant	Background of Study	Experience in PBL	Type of subject which PBL is practiced
Lecturer1 (L1)	Electrical Engineering	>3 years	Theoretical and lab-based
Lecturer2 (L2)	Education	>3 years	Theoretical
Lecturer3 (L3)	Medical	1-3 years	Theoretical, lab-based and applied
Lecturer4 (L4)	Education	>3 years	Theoretical
Lecturer5 (L5)	Mechanical Engineering	1-3 years	Theoretical and applied

Based on Table 3, all five lecturers practiced PBL in their teaching and learning and each of them has experience in PBL more than one year. One lecturer used theoretical and lab-based PBL approach. Two lecturers practiced only theoretical PBL approach. One lecture used theoretical and applied. The remaining lecturer practiced theoretical, lab-based and applied in his/her PBL approach.

Next section of the questionnaire focused on how each lecturer used assessment in his/her PBL approach and covered aspect such as what method of assessment they use, and what instrument of assessment method they applied to their students. All answers of the questions are summarized in Table 4.

From Table 4, we see that all five lecturers suggested formative and summative assessment in their PBL. Regarding with instruments of assessment method those frequently used by participants can be described as follows: - Formative assessment: All five lecturers utilized peer, group-report and group-presentation assessment. Self-assessment utilized by four lecturers (only L5, does not). Individual-activity assessment utilized by three lecturers (L3 and L5, do not). Whilst, log-book merely utilized by one lecturer (L1), and only one lecturer (L5) utilized portfolio.

Table 4: Details of Participants Answers

Participant	Method of Assessment		Instruments of Assessment Method	
	Formative	Summative	Formative	Summative
L1	Yes	Yes	Peer, self, Individual Activity, Group Report, Group Presentation, Log-book	Pretest, Post-test
L2	Yes	Yes	Peer, self, Individual Activity, Group Report, Group Presentation	Pretest, Post-test
L3	Yes	Yes	Peer, self, Group Report, Group Presentation	Mid-test, Final-test
L4	Yes	Yes	Peer, self, Individual Activity, Group Report, Group Presentation	Pretest, Post-test
L5	Yes	Yes	Peer, Group Report, Group Presentation, Portfolio	Interview, Final-Test

Based on this survey (suggestion from the lecturers) and the literature (common used assessments, Table 1), then the research summarized and selected appropriate assessment methods as a framework of PBL assessment (see Table 2).

5.2. Tool (CAPBLAT) Development

Tool development is the process of developing software through successive phases in an orderly way. This process includes not only the actual writing of code but also the preparation of requirements, the design of what is to be coded, and confirmation that what is developed has met objectives [14].

Functional Requirement

The tool developed based on the PBL Assessment framework (PBLAsF) that explained on the previous section 2. The fundamental thing that needs to be emphasized on the development phase is functional requirements, which aim to capture the intended behavior of the CAPBLAT. This behavior may be expressed as services, tasks or functions the system is required to perform the CAPBLAT. Business Process Diagram (BPD) and Use cases have quickly become a widespread practice for capturing functional requirements.

The BPD design helps to construct a use case diagram in order to capture user requirement utilizing the UML use case diagram[15]. With BPD, the researcher can understand how users work together, so we know what functions are needed by the tool and to be provided in order to help them. The following BPD (Figure 3) has been created based on the description of the framework (PBLAsF).

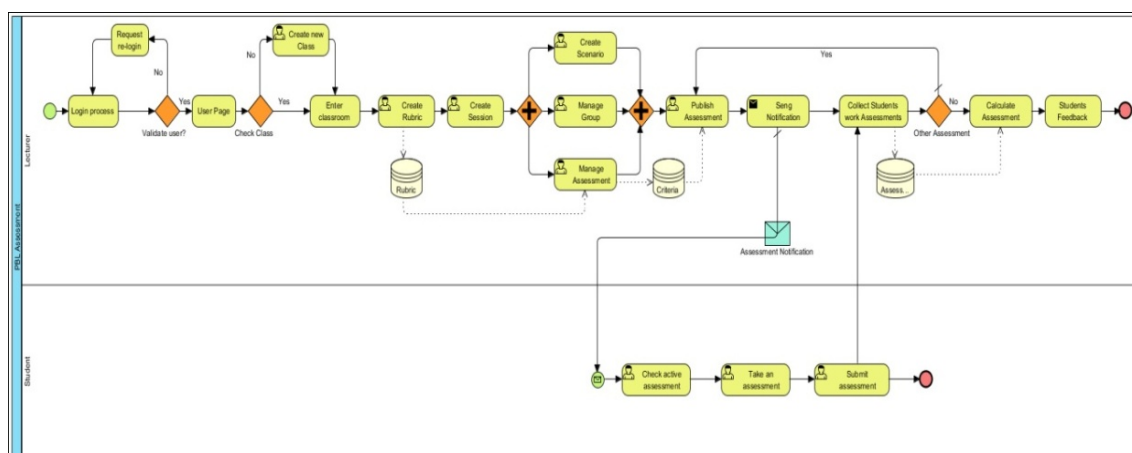


Figure 3. Business Process Diagram (BPD) for CAPBLAT

In the development phase, use case diagrams are used to gather the requirements of a system, including internal and external influences. The purposes of producing use case

diagrams in this phase can be as follows: - to gather requirements of software; - to get an outside view of software; and - to identify external and internal factors influencing the software. If the use case diagrams have been well-produced, the interactions among the requirements are the actors involved in the tool/software. Visual-Paradigm modeling for UML software has been selected to produce the use case diagrams.

The research identified initial use cases based on the framework and based on the BPD was depicted in the Figure 3 above, and then represented using the following Use Case Diagram.

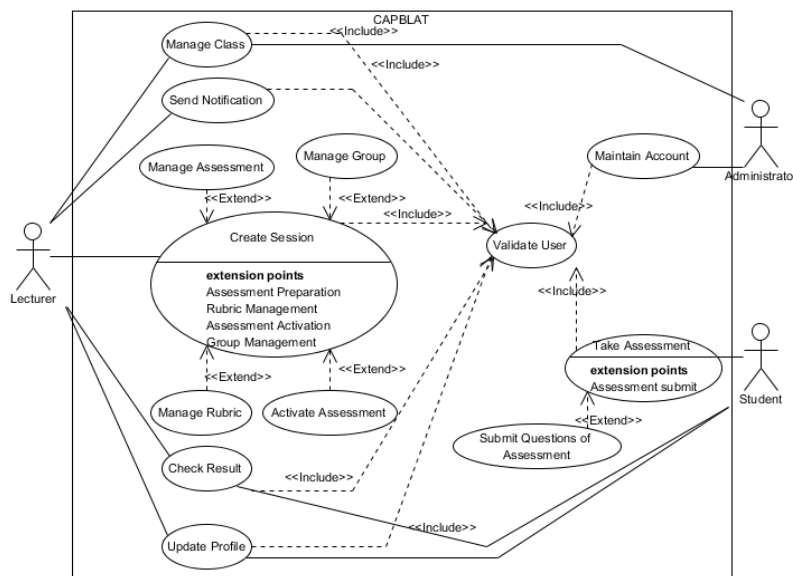


Figure 4. Use Case Diagram for CAPBLAT

Table 2. Description of Actors

Actors	Description
Lecturer	Any lecturer who use PBL approach and registered within the tool to assess his students.
Student	Any student in the PBL class which registered within the system to do his assessment.
Administrator	Who is the staff of the University whose role is to provide administrative support that enables the work of all tool's user to take place and has responsible for back-up the assessment activities.

Table 3. Description of Use Case

Actors	Description
Manage Class	To manage a class in PBL session
Validate User	To validate the user of CAPBLAT
Create Session	To create session during PBL session
Update Profile	To update student/lecturer' profile
Check Result	Allow lecturer and student to view the result
Send Notification	Allow lecturer to send out notification to students
Maintain Account	Allow user to manage his account
Take Assessment	Allow student to do the assessment

User Interface Design

Interface design is the process of defining how the system will interact with external entities (e.g., lecturers, students, other systems). According to Dennis, Wixon, et.al(2012)[15], the goal of interface design is to create a pleasant appearance of a system so that it would make easy for the user to interact with the system in a clear manner. In this section, the discussion focused on the design of user interfaces. For designing the user interface of CAPBLAT, the research pay attention to three principles from mechanisms of the user interface

design as suggested by Dennis and Wixom (2012)[15], which are, navigation mechanism, input mechanism, and output mechanism.

- Navigation Mechanism: to make the tool as simple as possible to use, it includes buttons and menus used by the user to maneuver from one page to another.
- Input Mechanism; a method used by the tool to capture information. The goal of input design is to capture accurate information about the system simply and easily[15].
- Output Mechanism; the way the system produces the reports to users, the goal of output mechanism is to present information to users so that they can accurately understand it with the least effort[15].

The Figures 5-8 are the samples of the CAPBLAT' user interface design.



Figure 5. User Interface of The Lecturer Page

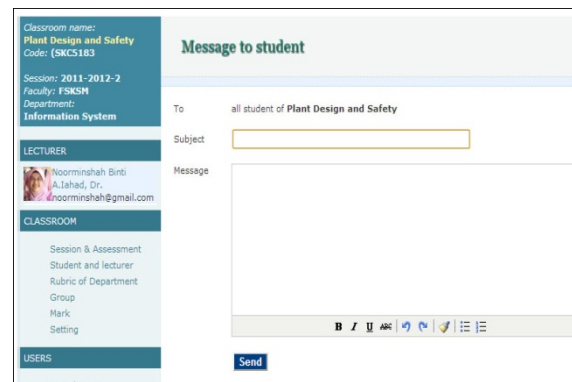


Figure 6. Interface of input Message Form

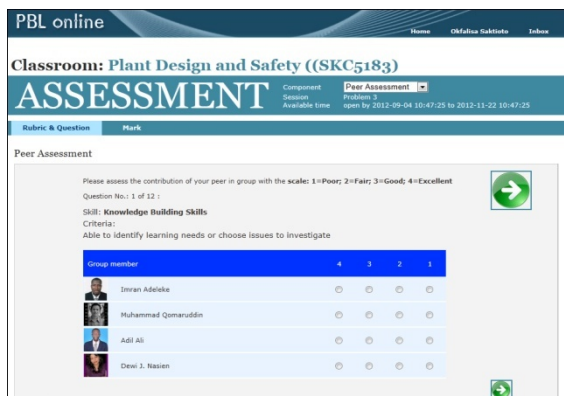


Figure 7. Interface of Peer-Assessment input Form



Figure 8. Interface of Student Mark Output

6. Conclusion

The development of CAPBLAT based on the PBLAsF for assisting lecturers in PBL assessment, was successful. The CAPBLAT is a well-designed tool for assessment especially in PBL approach. The tool is also recommended for the use in others approach learning such as active learning approach, due to its features that were designed for multi-platform learning assessment.

In the future, the study will discuss about tool testing and tool verification. Tool testing is a process of evaluating a system based upon its behavior during execution. The activity will include acceptance testing which to ensure that the tool meet the requirements and works as the user expected. The activity will also verify the framework which was embedded into the tool,

whether it matches with the expected objective. Verification process will be conducted to make sure the tool was built as per users' requirements.

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